Genetic X Environmental Interaction Parameters Of Friesian Cattle

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Abstract

Data collected on Friesian Heifers were used in this research to estimate genetic and non-genetic parameters. The average age at first calving (AFC), gestation period (GP), number services per conception (S/C), calving interval (CI), total milk yield (TMY), daily milk yield (DMY) and lactation length (LL) ranges were 24.9±2.34 - 26.50±2.84 months, 274.21±55.57 - 273.3±4.03 days, 3.92±2.77-2.3±1.7, 468.90±116.32 - 445.4±92.81 days, 5533.14±1546.03 - 3748.2±1095.2 kg, 15.10±3.58 - 11.00±2.42 kg, and 376.74±15.89 - 349.0±86 days respectively.

Results showed that parity number had a significant ($p < 0.05$) effect on (S/C). Also age at first calving had a significant ($p < 0.05$) effect on milk yield per lactation and daily milk yield ($p < 0.01$). Year of calving presented a significant ($p < 0.05$) effect on DMY, S/C and (CI) ($p < 0.001$). Whereas place of birth had a highly significant effect ($p < 0.001$) on TMY and significant ($p < 0.01$) effect on AFC.

Repeatability estimates for GP, S/C, CI, TMY, DMY and LL were found to be 0.170±0.045, 0.090±0.044, 0.361±0.047, 0.420±0.061 and 0.094±0.044, respectively. While heritability estimates by paternal half-sib method ranged from 0.003±0.078 for LL and 0.190±0.140 for AFC. Whereas, estimates calculated by daughter-dam regression were found to be 0.710±0.456, 0.320±0.168, 0.106±0.120, 0.100±0.150, 0.174±0.136 and 0,055±0.224 for AFC, GP, S/C, TMY, DMY and LL, respectively.

Regarding phenotypic correlations among parameters, age at first calving was negatively correlated with other traits except for S/C and DMY. Whereas S/C exhibited positive phenotypic correlation with all the traits studied. Total milk yield was found to have positive correlation with DMY and LL. Concerning genetic correlations among traits were either inestimable or overestimated.

Keywords: *Friesian, climate, Genetic, non-genetic, parameters*

1. Introduction

In Libya great interest for dairy cattle rearing has taken place by farmers and businessmen. This is because of the existence of inelastic market for milk all year round, in addition to the provision of the regular income for the producer resulting from fluid milk sale in the urban centers. The relatively poor potential of the local dairy cattle necessitates the importation of exotic high milk producing breeds in order to fill the gap between milk consumption and actual demand besides improving the genetic potential of the indigenous dairy breeds by crossing and selection.

The maximum yield of these pure-bred cattle can hardly be attained under Libyan conditions because of the genotype X environment interaction. The adverse environmental conditions which include less adequate feed, prevalence of endemic diseases and harsh climatic conditions are the main predisposing factors that prohibit the standard production potential of the dairy sector in Libya.

According to the different strategies suggested for filling the gap between milk demand and supply, the feasibility of importing pure exotic cattle to achieve this goal was strongly debatable among politicians and dairy breeders. Therefore, the objectives of this study are:

- To assess the productive and reproductive pattern s of pure Friesian dairy cattle in Libya.

- To estimate genetic parameters of the herd.

- To suggest plans for future development of the strategy for dairy farming in Tripoli state.

2. Materials and Methods

2.1 Structure and Management

The study was conducted at Tripoli- Libran Dairy Farm Tripoli city is located in the north-western part of Libya at 32° 54' North latitude and 20° 4' East longitude, Tripoli city has a hot subtropical semi-arid climate with long, hot and dry summers with relatively wet and mild winters with a Mediterranean (dry-summer) rainfall pattern. Its summers are hot with temperatures that often exceed 38 °C (100 °F); average July temperatures are between 22 and 33 °C (72 and 91 °F). In December, temperatures have reached as low as 0 °C (32 °F), but the average remains at between 9 and 18 °C (48 and 64 °F). The average annual rainfall is less than 400 millimetres (16 inches), and can be very erratic. Open housing system was the base in this farm, water was provided by automatic drinkers. The animals were kept in pens. Calves were grouped according to age or live body weight. Adult cows were divided into lactating, late pregnant and dry according to their physiological status. Feed requirement was determined according to milk yield and or body weight. Both natural and artificial mating systems were used in the farm. Well- fed heifers were considered to reach sexual maturity after their live weight becomes 370 kg that is attained normally on 16 months of age.

2.2 Recording System

The types of records available in the farm included: feeding, reproductive, milk yield, and herd structure records. Data obtained were classified according to seasons which included (autumn, winter and summer). Data were also grouped according to place of birth into two groups, namely imported and homebred.

2.3 Statistical Analysis

The data were analyzed using GLM of SAS (1988) to obtain the analysis of variance, and DMRT was used to test for significant differences. Genetic parameters estimates were conducted by Harvey's (1990).

The analysis of variance for the traits was performed by the following model:

$$Y_{ijkmn} = \mu + A_j + S_j + P_k + B_m + e_{ijkmn}$$

Where:

Y_{ijkmn} = the nth observation on cow calved first at the age in the jth season within k^{th} period at m^{th} place of birth,

μ = the overall mean, A_j = the effect of the ith age at first calving group (i= 2,3and 3), S_j = the effect of the jth season of calving (j=1,2 and3), P_k = the effect of the kth period of calving (k=1,2 and 3), B_m = the effect of the mth place of birth (m=1 and 2), e_{ijkmn} = the random error.

The following model was used to show the effect of place of birth on age at first calving:

$$Y_{ij} = \mu + B_i + e_{ij}$$

Where:

Y_{ij} = the jth observation for cow birthed at the ith place, μ = the overall mean., B_i = the effect of ith place of birth (i = 1 and 2), e_{ij} = the random error.

Repeatability for the traits studied were estimated by intra-cow correlation by the following

equation described by Becker (1984)

$$R = \sigma^2 b / \sigma^2 b + \sigma^2 e$$

R = repeatability, $\sigma^2 b$ = variance between cows, $\sigma^2 e$ = variance between records within cows.

3. Results and Discussion

The average age at first calving (AFC) for the imported and homebred Friesian heifers were found to be 24.91±2.51 and 26.50±2.84 months respectively with coefficients of variation of 9.75% and 10.71%. (Table 1). This is similar to the findings of Ibrahim (1989) for Friesian cattle in Sudan. However it is lower than 39.2±7.5 that obtained by Tadesse et al (2010) in Ethiopia and 987.87 ± 9.81 days and that stated by Sattar et al (2005) in Pakistan for the same breed. The age at which the imported heifers commenced calving was significantly (p< 0.01) less than that of homebred heifers. Table 2. This may indicate that sufficient feeding in the early life of the cows is important to obtain normal growth in relation to their age (2 years).

The average calving interval (CI) was 468.90±116.32 and 445.40±92.81 days for imported and homebred Friesian cattle, respectively. This result agreed with Tahir and Maarof (1990) ones in Iraq and seemed to be higher than 414.5±5.8 days reported by Salah and Mogawer (1990) for the breed in Saudia Arabia. The trait was significantly (p< 1.001) affected by year of calving and parity number. But season of calving did not significantly (p< 0.05) affect this trait. Table 2. Tahir and Maarof (1990) also reported significant effect of period of calving on the trait. . Fadlel Moula (1994) reported significant effect of parity number for Friesian crossbred, while Mbap and Ngere (1989) reported that this trait was insignificantly affected by parity number as well as season of calving. Also Mohamed Khair et al (2007) reported a high significant (p< 0.001) effect of parity on CI for Friesian crossbred in Sudan.

Gestation Period (GP) was found to be 274.21±15.57 and 273.30± 4.03 days for imported and locally born Friesian cows, respectively. Table 1. This result is in line with that obtained by Seida and Sayed (1990) in Egypt . While Osei et al (1991) reported slightly higher results. On the other hand Gwaza et al. (2007) reported 270±5.72 days in Cameroon. However, all values were considered to be fallen with the accepted range of the breed. Year of calving, Parity and season of calving were found to have no significant effect on pregnancy duration (Table 2). Similar results of the effect of year of calving were expressed by Younis et al. (1976) for the same breed in Kuwait. However Sang et al. (1986) found that year of calving had significant influence on gestation period. Rafique et al. (2000) reported non-significant influence of parity number on this trait. On the other hand, Sang et al. (1986) found a significant effect of season of calving on pregnancy duration. The non significant effect of the year of calving, parity and season of calving on the trait may be attributed to the fact that this trait has almost a constant period during the life cycle of the cow.

The average (Services per Conception) S/C was found to be 3.92±2.77 and 2.3±1.70 for imported and homebred, respectively Table 1.

Table 1. Means, Sd, CV of traits of the Imported and homebred Friesian Cows

Trait	Imported			Homebred		
	Mean	S.D.	C.V.%	Mean	S.D.	C.V.%
AFC(months)	24.91	2.43	9.75	26.50	2.84	10.71
GP (days)	274.21	15.57	5.67	273.30	2.84	1.47
S/C	3.92	2.77	70.66	2.30	1.70	73.91
CI (days)	468.90	116.32	24.80	445.40	92.81	20.83
TMY (kg)	5533.14	1546.03	27.94	3784.2	1095.2	28.94
DMY (kg)	15.10	3.58	23.70	11.00	2.42	22.00
LL (days)	376.74	150.89	40.05	349.00	86.19	24.69

This value is higher than 2.0 reported for Friesian dairy cattle in Nigeria by Ngodigha et al (2009) and 2.11 for Friesian in Pakistan (Niazi and Aleem 2003). While it is lower than the findings of Gyawu et al (1990) in Ghana and 3.07±0.10 which is reported by Sattar et al (2005) in Pakistan. These differences might be due to variations in the management, environment and fertility status of the breeding cows. This trait displayed a significant (p < 0.05) variation with respect to the year of calving and parity number Table 2.

Table 2. Mean Squares of the factors affecting the measured traits

Source of variation	df	TMY	LL	DMY	GP	S/C	CI	AFC
Parity	5	2310689.8	33287.38	49.72***	173.31	843.57*	62036.8***	-
AFC	3	6951437.3*	6559.10	41.64**	170.85	471.74	13820.79	-
Season of calving	2	1617175.9	37838.97	25.38	158.02	532.51	18692.11	-
Year of calving	2	1108123.6	18882.45	45.40*	115.08	1066.11*	95930.9***	
Place of birth	1	93993720***	47747.77	330.53***	0.75	607.64	1014.09	55.93**

*= p< 0.05;   **=p<0.01;   ***=p<0.001

This result is in line with that stated by Mangurkar et al (1986). While Tadesse et al. (2010) reported non-significant effect of parity number on the trait for Friesian cattle in Ethiopia. Season of calving have no significant (p < 0.05) effect on the trait, this agreed with Njubi et al (1992) and disagreed with Juma and Al-Samarai. (1987).

In the present study the mean (Total Milk Yield) TMY for imported and homebred cows were 5533.14±1546.03 and 3784.20±1095.2 kg respectively. Table 1. The later result is in line with 3710 kg that obtained by Tadesse et al (2010) for Friesian in Ethiopia but less than 5905 kg that found by Ajili et al (2007) in Tunis, 4489 kg/cow in southern Malawi by Wollny et al (1998) and that reported by Ahmed et al (1997) in Libya. On the other hand it was more than that stated by Mbap and Ngere (1989) and Davinder and Jai (1983). (DMY) obtained in this study was 15.10±3.58 and 11.00±2.42 kg for imported and locally born Friesian cows, respectively. This amount was more than that reported by Morsy *et al.* (1990) while it is less than the findings of Gwaza et al (2007) in Cameroon, Ahmed et al (1997) in Libya and Petrovic (1992) in Yugoslavia. This shows that there are great variations in milk yield for Friesian cattle in different places. This could be attributed to variation in managerial practices such as nutrition, disease control in addition to the effect of climatic conditions.

Parity number had a significant effect (p < 0.001) on milk yield per day and non-significant effect on total lactation milk yield. A significant influence on DMY was also reported by Mbap and Ngere (1989) and Mohamed Khair et al (2007) that reported a significant effect on TMY also, while non-significant effect was stated by Amasaib et al (2008) for Friesian crossbred in India. The result of this study exerted that milk yield increased with the increase in parity, to attain a peak value at third lactation and started to decline thereafter. These results were in consistency with those suggested by Sattar et al (2005), Mbap and Ngere (1989) and Morsi (1986).

The non-significant effect of season of calving in TMY and DMY in this study was also confirmed by Subandriy et al (1986) and El-Amin et al (1986). Whereas Siqueria et al (1984) reported significant effect of season of calving on TMY. El-Amin et al (1986) reported that the highest milk production was produced by cows that calved in autumn but in the present study the highest milk production was recorded by cows that calved in winter and the lowest by summer. The place of birth had a significant (p < 0.001) influence on milk production. Foundation cows significantly produced more milk compared to those born in the herd, this finding agreed with Njubi et al (1992). This could be due to the differences in environmental conditions between countries of origin and tropical countries.

The averages (Lactation Length) LL for imported and locally bred Friesian in this study were 376.74±150.89 and 349.00±86.19 days respectively. This length fell within the range reported by Skalicki and Latinovic (1990) and Juneja et al (1991) who recorded almost similar results (344 days) LL in Friesian cows in India. However, a shorter means (291.86±6.55 days) was stated by Sattar et al (2005) and Alim (1986) in Libya. In this study LL is not significantly affected by year of calving, season of calving and parity number. The non-significant effect of year of calving is agreed with Dhumal et al (1989) and disagreed with Karan and Joshi (1990). Njubi et al (1992) supported the non-significant effect of parity on the trait, while Mohamed Khair et al (2007) found a significant effect in Friesian crossbred in Sudan. The results revealed that cows calved in winter lactated for longer period than those calved in other seasons. Whereas Nartey (1990) reported that cows calved in the rainy season had longer lactation length than those calved in dry season.

Table 3 shows the estimates of genetic parameters e of traits studied. Heritability (h2) can't be estimated easily with great precision, and most estimates have rather large standard errors. Different estimates of the same character on the same organism show wide range of variation, some of which may reflect real differences between populations and /or the conditions under which they are studied (Falconer, 1982).

Table 3. Repeatability and Heritability estimates

Trait	r^2	h^2 A	h^2 B
AFC	-	0.190±0.140	0.710±0.456
GP	0.170±0.045	0.141±0.123	0.320±0.168
S/C	0.090±0.044	NE	0.106±0.120
CI	0.121±0.044	NE	NE
TMY	0.361±0.047	NE	0.100±0.150
DMY	0.420±0.061	0.062±0.098	0.177±0.136
LL	0.094±0.044	0.003±0.078	0.055±0.224

NE = Non-estimable., h^2 A = Heritability estimated using paternal half-sib., h^2 B = Heritability estimated using daughter-dam regression.

The h^2 estimate of AFC obtained by paternal half-sib correlation was found to be 0.190±0.140. Table 3. High estimates for the same trait were reported by Khattab and Sultan (1993) and El-Amin et al (1986) for Friesian and Friesian crossbred in Sudan, respectively. While Moore et al (1990) reported lower estimate of h^2 of AFC estimated by daughter-dam regression. h^2 of GP estimated by paternal half-sib method was found to be 0.141±0.123. Table 3. This estimate fairly agreed with Moore et al (1990) whereas El-Amin et al (1986) reported a lower estimate for the same trait. h^2 calculated by daughter-dam regression is higher than that obtained by El Amin (1969).

Heritability of TMY estimated by daughter-dam regression was within the range reported by Mosi (1988) for Friesian cattle in Kenya. Whereas Siqueria et al (1984) and Ali Hashemi et al (2009) found lower and higher estimates respectively. h^2 for DMY estimated by paternal half-sib and daughter-dam regression were found to be 0.06±0.098 and 0.0174±0.136 respectively (Table 3). Both estimates were lower than that recorded by Arendonk et al (1987) for Dutch Friesian cows but less than 0.04±0.14 that recorded by Gwaza et al (2007) for Friesian in Cameroon. h^2 for LL was found to be 0.003±0.078 using paternal half-sib correlation. This was lower than the findings of Skalicki and latinovic (1990) and Duarte (1983). In general the estimates of productive traits in this study were very low, so any effort to improve these traits by selection within the herd would be ineffective and the most useful way of improving these traits would be by improving management level.

Repeatability (r^2) estimates for reproductive traits were relatively low. r^2 estimates for GP is higher than the one obtained by El Amin et al (1986) and lower than that obtained by Sang et al (1986) for Holstein Friesian in Korea. On the other hand r^2 estimates for S/C is almost similar to the findings of El Amin et al (1986), but it is higher than that explained by Tong et al (1979) and lower than that reported by Raheja (1989). r^2 for TMY and DMY were relatively medium and in consistent with the results of Chand and Narain (1986) but higher than the estimates of Alim (1986) and lower than the findings of Canon et al (1990). On the other hand r^2 estimates for LL was found to be lower than that explained by El Itriby and Asker (1956). Falconer (1982) reported that the repeatability differs very much according to the nature of the character, and also of course, according to the genetic properties of the population and the environmental conditions under which the individuals are kept. In the present study the variation in repeatability estimates may be attributed to the differences in the records used in calculation of the values. Regarding genetic and phenotypic correlations Table 4.

Table 4. Genetic and phenotypic correlations among traits

Trait	AFC	GP	S/C	TMY	DMY	LL
AFC						
GP	-0.047				0.187±0.84	0.53±0.71
S/C	0.130	0.101				
TMY	-0.116	0.014	0.094			

| DMY | 0.063 | 0.191 | 0.075 | 0.0325 | | |
| LL | -0.075 | -0.068 | 0.009 | 0.480 | 0.362 | |

 *Genetic correlation above diagonal, phenotypic correlation below diagonal.

AFC was negatively correlated with GP and positively with S/C, this finding is similar to the results of Moore *et al*. (1990) and Abubakar *et al*. (1986) who reported a negative phenotypic correlation between AFC and GP and between AFC and TMY. Whereas Barrada et al (1969) and El Barbary et al (1983) reported positive phenotypic correlation between AFC and TMY. In this study correlation between AFC and DMY was positive and low, this agreed with the result of Patro and Rao (1983). Also AFC was negatively correlated phenotypically

with LL, this was disagreed with the result of Davinder and Jai (1983). TMY was positively correlated with all traits except AFC. Positive correlation with LL was also reported by Mohiuddin et al (1992), positive correlation with S/C was agreed with Vij and Tiwana (1986) who were also reported negative phenotypic correlation with GP and TMY. LL was negatively correlated with GP; this was disagreed with the findings of Abubakar et al (1986).

In this study, standard errors of genetic correlation were relatively high. This might be due to the effect of sampling since the number of records used was small due to the incomplete information reported in the records. Genetic correlation of GP with milk productive traits was found to be positive. Positive and high genetic correlation between GP and LL was also reported by Abubakar *et al*. (1987) and Pogacar (1982). The positive genetic correlation between traits indicates that if one trait is genetically improved, the other trait will also improve.

4. Conclusions

In hot climates raising crosses is far better than raising pure exotic cattle due to their better adaptation to the environment.

Because of the difficulties associated with pure exotic breeds requirement for high level of management, that might not be available in developing countries, therefore we suggest using cross breeding with indigenous as a suitable alternative. Moreover, giving more care to feeding of calves in early life has a great impact on future performance. Heritability and repeatability were moderate but similar to previous literature estimates from studies that used a comparable model in the same population, indicating the possibility of a satisfactory response to selection for these production traits in Libyan Friesian. Genetic parameters estimate in this study might be used in the official genetic evaluation for production traits for Libyan Friesian Cattle.

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